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ABSTRACT

Certain tasks in programed instruction can be performed only by computer. One such area is the arrangement of differential reinforcement for sophisticated reinforcement contingencies. That is, the capacity of the computer is required to determine whether the student has met the criterion for reinforcement. With this in mind, a computer-controlled program was designed to teach young children to classify a single array of objects many different ways. The child was presented with many objects and asked to touch all the things that were alike. As he classified the objects by color, shape, size, and the like, the computer presented appropriate reinforcements. Testing of this program showed it was successful in reaching a low error rate and satisfactory improvement in the skill of multiple classification. The computer successfully managed reinforcement contingencies for this task which would be difficult or impossible to arrange with simpler devices or procedures. (JK)

The Use of a Computer for Programmed Instruction Presentation of a Pre-School Classification Program

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AERA, New York, 1971

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The object of this study is to demonstrate a potential use of computers in essentially linear programs which nevertheless require the capacity of the computer to determine whether the condition for differential reinforcement has been met. In a great many cases the task being taught is of a relatively simple and conventional type which can easily be done with devices much more simple than a computer. In instances in which the computer and other modes such as simple teaching machines can perform similar functions, one may compare the relative advantages of the two in terms of cost, ease of implementation, and other factors. But a computer should be able to manage much more difficult tasks than other devices. The question then becomes: What kinds of tasks can not be done except by computer? One such area is the arrangement of differential reinforcement for sophisticated reinforcement contingencies. That is to say, the capacity of the computer is required to determine whether or not the student has met the criterion for reinforcement. With this in mind, we devised a computer-controlled program to teach young children to classify a single array of objects many different ways. The instructional objective of the demonstration program is to further the development of "formal logic," i.e., the ability to form class concepts and the ability to classify on the basis of relationships that exist between classes

EM 009 367

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or the things within a class. The child learns to match things on the basis of some identical perceptual quality (e.g., color, shape), on the basis of some abstract quality (e.g., fruit, animals), and on the basis of use or function (e.g., toys, clothes) The child also practices using the concepts all, alike, same and except. But the most interesting aspect, and the one which requires the most in computation, is that the child learns to classify a single collection of objects a number of different ways beginning with any attribute he wishes and classifying on the basis of each attribute before he finishes with the collection of objects.

The 160-item classification program began with simple identification of membership of objects in a single class and progressed finally to arrays of objects that can differ in a number of different dimensions. On late items, the child gave unprompted classifications on each of the several dimensions.

Each item was separately photographed and presented with a 35 mm carousel projector onto a touch-sensitive display, a computer interface device which transmits the location of a touch by the child to the computer. The computer, a PDP7/9, was programmed to determine with each successive touch whether the collection of objects touched was a permissable collection and, whether or not it was a collection already completed by the subject. In either case, appropriate messages were presented by a random access auditory device (CROW).

Examples of the item types are found in your handout. Item types I through IV familiarize the child with the categories included in subsequent multiple category items (Type V). An example

from a multiple category item will serve to illustrate the ability of the computer to handle complex reinforcement contingencies.

- - - - - - - - - - -
See Handout, Page 5
or
Poster
- - - - - - - - - - -

The child is asked to, "Touch all the things that are alike." The child can put these together in many ways using color, shape and size. If the child fails to touch an object within 15 seconds, the original message is repeated. If the child completes a set, e.g., touches all the things that are blue, he sees a light flash. He is then instructed to, "Find some more things that are alike." If he were again to select the objects that are blue, he would hear, "You already did that. Try again." He may then, for instance, touch all the things that are green. If he neglects to touch all of the green ones, after ten second he hears, "You didn't find all of them. Try again." If he then completes the green set, the light flashes. He is then again instructed to, "Find some more things that are alike." He may touch all the circles, or the squares, or the yellow ones, etc. If he happens to make an invalid set, e.g., the small green circle and the large blue square, as soon as he touches an inadmissable member, he is told, "Those don't go together. Try again." After all sets are completed, in this case, big, little, square, circle, triangle, blue, green, yellow, the child is reinforced with a bell, light and marble.

If the child is unable to classify on some attributes, the computer will present each uncompleted set independently, e.g., "Find all the squares." Then, "Find all the circles," etc. After

completing all the missed sets in this fashion, the original instruction will be presented again, "Find all the things that are alike." The child starts again to classify the objects.

I should point out here that the above example is not the typical case because the child generally makes few mistakes; the error routines are the exception, not the rule.

The number of sets in the multiple-category items ranged from two to six. One group of subjects was required to complete all of these sets (the 100 percent criterion group). Another group was not required to complete all of the possible sets. For this group, the number of sets required per item was the nearest whole number that does not exceed three-quarters of the total possible sets. The average was 62 percent of the sets.

The results demonstrated considerable success in reaching a low error rate and satisfactory improvement in the skill of multiple classification. The children completed the program in approximately five or six twenty-minute sessions. Overall average error rate per item for first opportunity responses was 11 percent (with a range from 4 to 24 percent). Error rate for the multiple-category sets was 20 percent (with a range from 5 to 30 percent). There were differences between subjects with the 100 percent criterion and those with the 62 percent criterion. For both sets of subjects there was a statistically significant improvement in posttest performance as compared with the pretest performance. In each case, the p value was less than .001. For the 100 percent criterion group, performance improved from an average pretest score of 41 to an average posttest score of 84. For the 62 percent cri-

terion group, performance changed from an average pretest score of 30 to an average posttest score of 61. In both instances, the scores approximately doubled. Unfortunately, although group assignment was random, a sizable difference occurred between the groups in pretest performance tending to obscure comparisons between the two criteria. An analysis of covariance was used to adjust for this mismatching. The adjusted posttest mean for the 100 percent criterion group was 82 and the adjusted posttest mean for the 62 percent criterion group was 63. This difference in posttest performance between the two groups favoring the 100 percent criterion group is what one would expect; however, using an analysis of covariance, the difference fails to reach statistical significance. It seems likely that a larger n would demonstrate an advantage.

In general, the results demonstrate that the program attained a reasonably low error rate and substantial improvement in posttest behavior. The success of the program is most striking when one remembers that the subjects were age six, and Piaget places this ability in his stage 3 which begins at age nine or ten.

The computer successfully managed reinforcement contingencies for this task which would be difficult or impossible to arrange with our more simple devices or procedures. The only other procedure practical would be to have a teacher monitoring the behavior and determining whether the subject was always touching possible categories and keeping track of whether the category was already covered. This would be done most imperfectly and would be prone to a great many errors, and might, in fact, not be generally practical.

Some CAI programs which claim a basis in programming principles (cf., Suppes, 1966) generate a need for the computer capacity largely by partially ignoring good programming practice. Thus the drill and practice programs for math and spelling use high error frequencies to differentially weigh items for drill. The high error rates are generated by a lack of programming and by giving little attention to the hierarchical structure of the subject matter. Others, such as the Stanford reading program (Atkinson, 1968), use a basic underlying linear program with remedial items on incorrect answers. There is work for the computer only to the extent that the program is defective enough to cause the subject frequently to be unable to perform a mainline item.

The present program, in contrast, attempts, with some success, to obtain a low error rate in a program in which the computational capacities of the computer are amply used in determining whether or not the subject has attained the condition for reinforcement. There are no doubt a number of other normal educational objectives which can not easily be arranged without using the capacity of the computer, e.g., gaming and complex decision making in the context of simulated dynamic tasks such as simulated economic systems in business schools. However, such tasks seem all too rare in traditional academic education. For that reason, the present results, though encouraging, can not be considered a particularly strong general endorsement of the possible widespread application of computer-assisted instruction to educational tasks. However, a possibility remains that in educational practice we have taught only those things which have seemed possible to teach. Perhaps the opening of new possibilities in education via the computer will greatly extend the things we will teach in the future.

THE USE OF A COMPUTER FOR PROGRAMMED INSTRUCTION PRESENTATION OF A PRE-SCHOOL CLASSIFICATION PROGRAM

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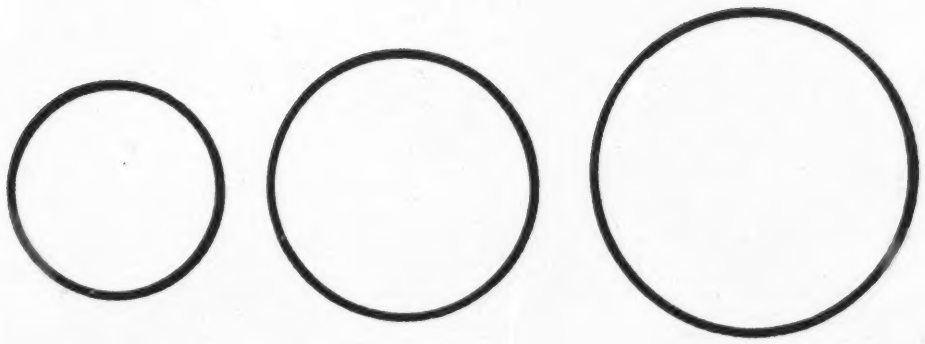
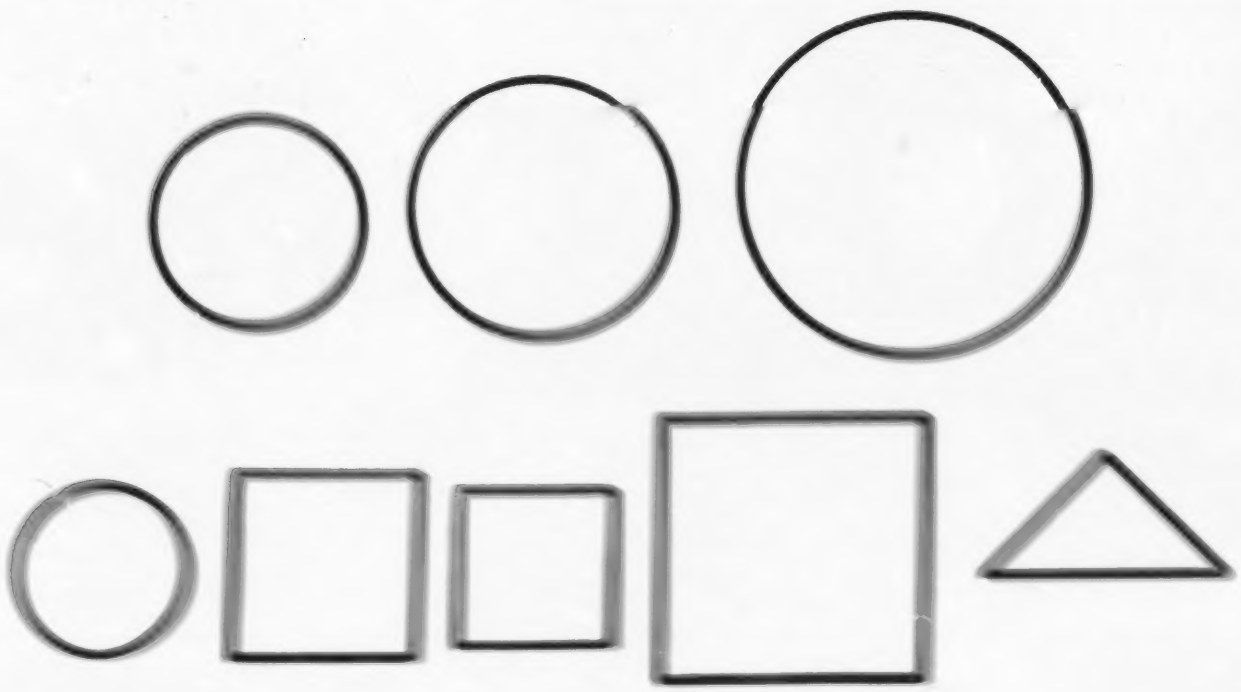
taken from a paper presented at the Meetings of the American Educational Research Association, New York, February, 1971.

ITEM TYPE I



SLIDE I



SLIDE II

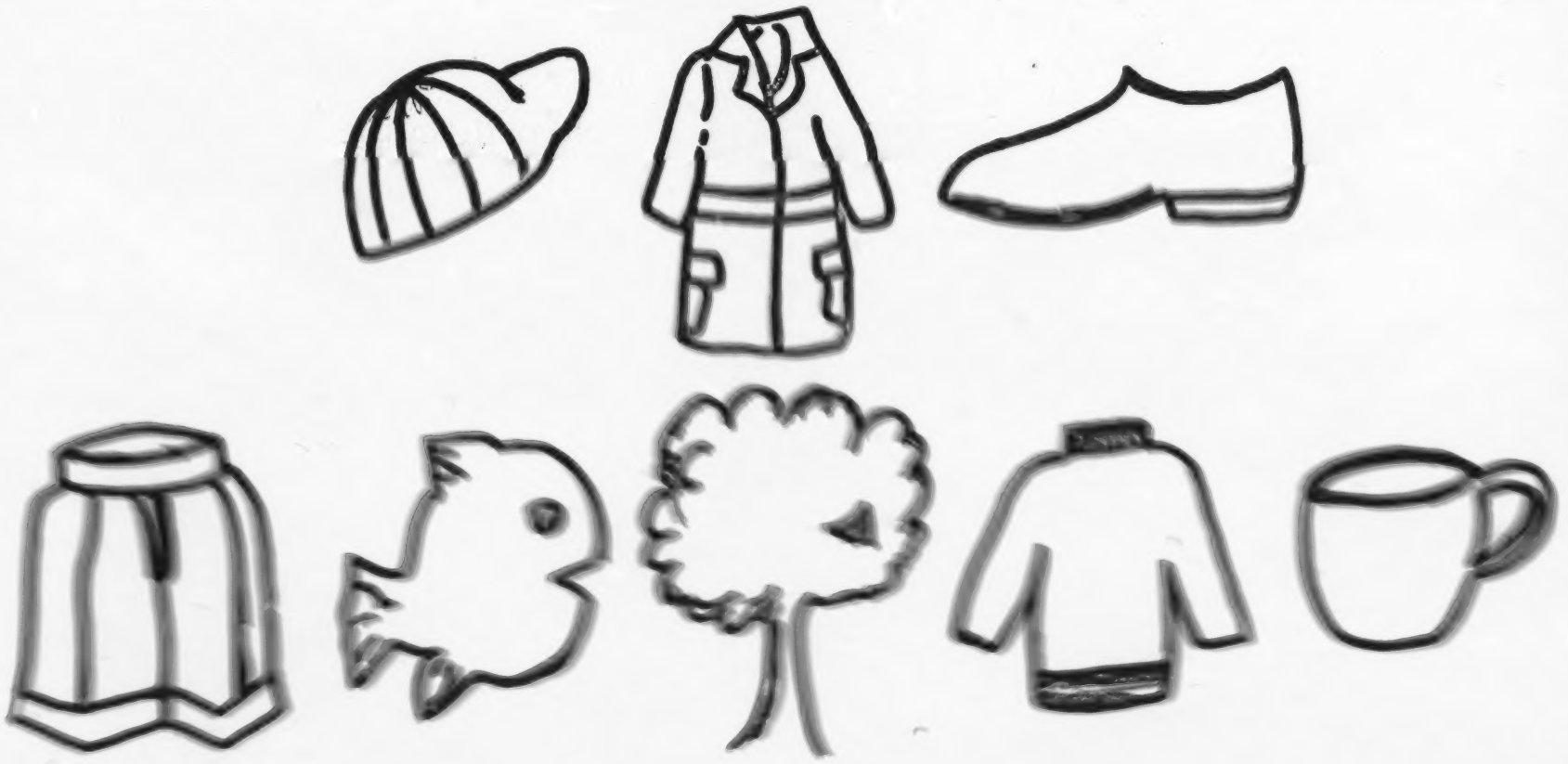
CROW MESSAGES:

SLIDE I: These are circles.
SLIDE II: Find another circle.

Item Type I presents the child with a series of objects all having one common attribute (Slide I) and asks him to select an object from another series (bottom row of Slide II) which has the same attribute.

ITEM TYPE II

SLIDE I



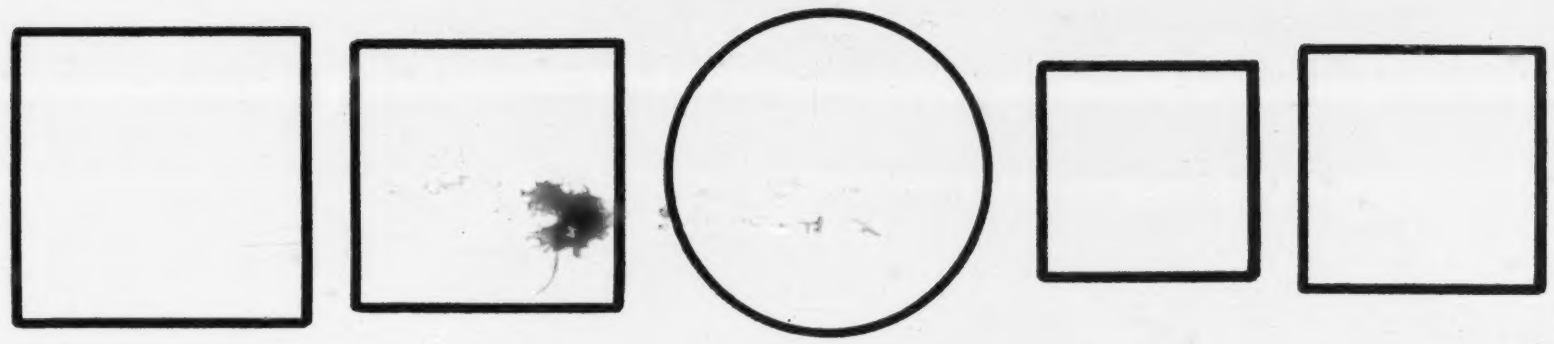
SLIDE II

CROW MESSAGES:

SLIDE I: The hat, the coat, and the shoe are clothes.
SLIDE II: Find some more clothes.

Item Type II presents the child with an array of objects all having one common attribute and asks him to find as many examples as he can of objects having the same attribute.

ITEM TYPE III

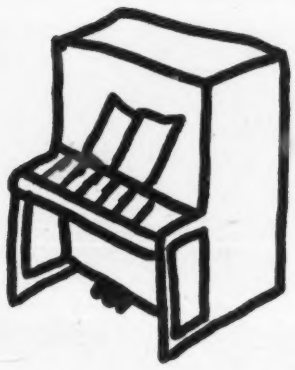


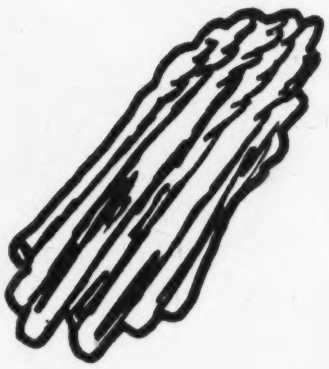
CROW MESSAGE:

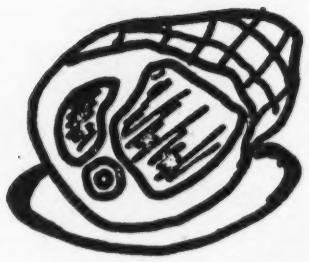
All of these are squares except one. Which one?

Item Type III presents the child with an array of objects and asks him to select the one that is different.

ITEM TYPE IV





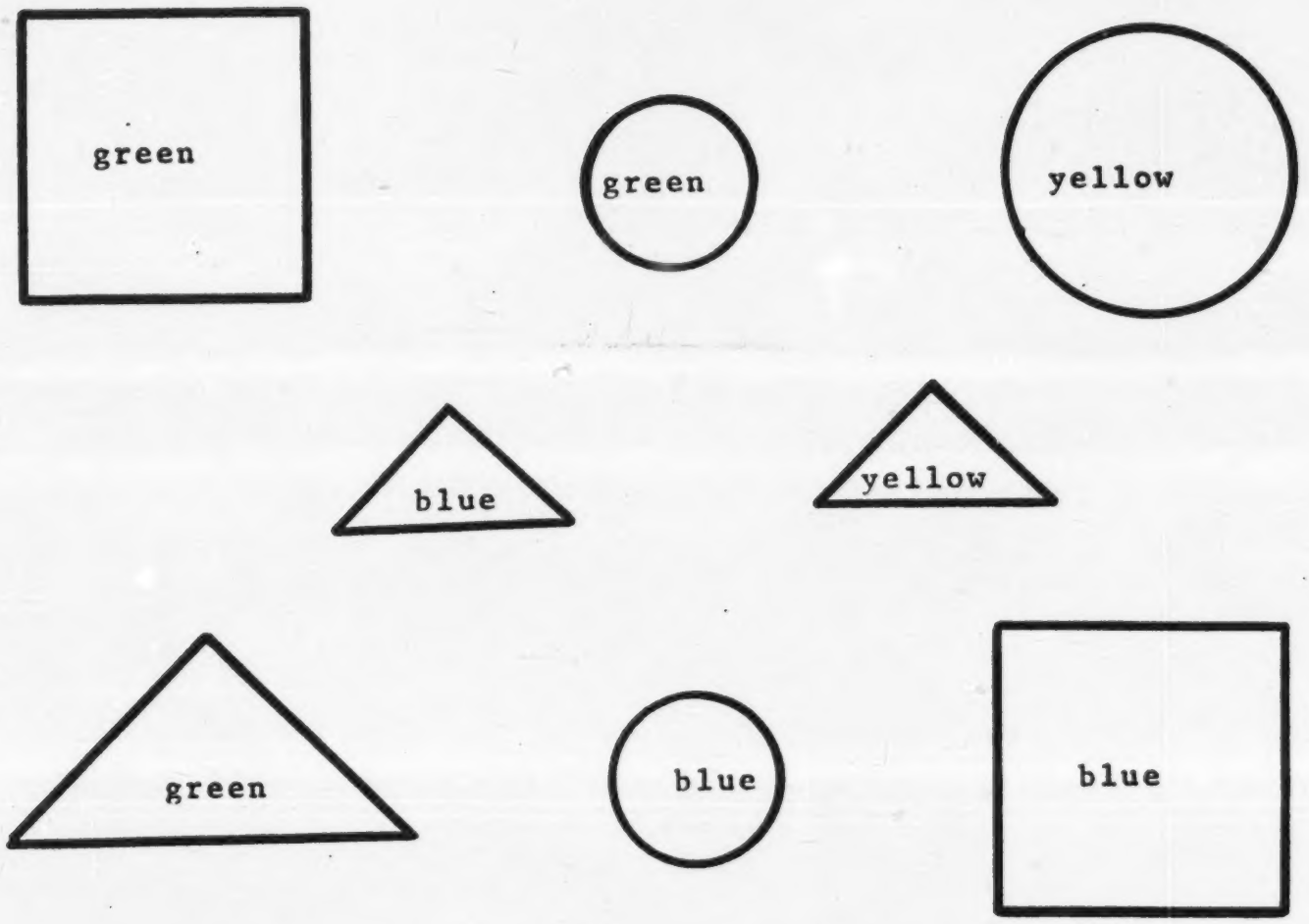


CROW MESSAGE:

Find all the food.

Item Type IV asks the child to find all those objects in an array which have the same common attribute.

ITEM TYPE V



CROW MESSAGE:

Touch all the things that are alike.

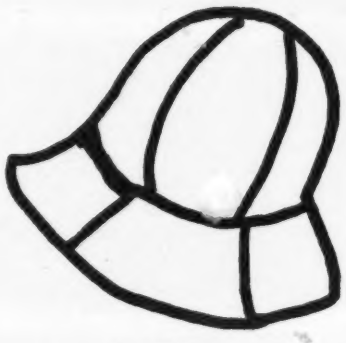
Item Type V, which occurs at the end of the teaching sequence, asks the child to put an array of objects together as many ways as he can. This item type reflects criterion performance on the teaching task in that it asks the child to classify a group of objects using several attributes.

ITEM TYPE V

green

blue

yellow



yellow

green

blue

blue

yellow

green

CROW MESSAGE:

Touch all the things that are alike.

Categories: hats, coats, pants, blue, green, yellow

ITEM TYPE V

CROW MESSAGE:

Touch all the things that are alike.

Categories: hot, cold, metal, wood, furniture